REMARKS

By this amendment, applicants have amended claims 28 and 30 to be in independent form; specifically, claims 28 and 30 have been amended to include therein the limitations previously recited in independent claim 1 from which claims 28 and 30 previously depended. Noting that claims 28 and 30 were previously multiple dependent claims, applicants have also added claims 34 - 39 corresponding to claims 28/5, 28/6, 28/7, 30/5, 30/6 and 30/7, respectively. Applicants have also added new claim 33 defining the high strength Mg based casting alloy, including, inter alia, 0.5 to 10% by weight of Sn. See, page 8, lines 2 - 19 of applicants' specification. Applicants have amended independent claims 1, 2, 7 and 8 to specify that the Mg based casting alloy contains at least 12% by weight of Al. See, the paragraph bridging pages 7 and 8 of applicants' specification. Claim 5 has been amended (and the amended language included in new independent claims 34 and 37) to change "one kind or more than two kings of elements selected from the group consisting of Ca, Si and rare-earth elements" to read --at least one element selected from the group consisting of Ca, Si and rare-earth elements--. The preambles of claims 28 - 32 have been amended to read "A high strength Mg based casting alloy--.

Claims 1, 2, 4 - 11, 22 - 24, 27 and 31 stand rejected under 35 USC 103 as being unpatentable over United States Patent No. 2,005,115 to Wood, DE 1,301,914, NO 20 675 or United States Patent No. 4,332,864 to King et al "in view of acknowledged prior art admission from page 1, line 11 to page 3, line 15 of the instant specification." Applicants traverse this rejection and request reconsideration thereof.

The invention as presently claimed herein is directed to novel Mg casting alloys,

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which are injection molded using a metal mold, and which can be effectively utilized for various products.

Various casting Mg alloys, such as AZ91D, have been utilized. However, with the growing need for relatively thin products, and high precision of, e.g., cast parts, to reduce weight and size of portable devices, high fluidity alloys have been required. The fluidity may be improved by raising the temperature of the molten alloy; however, raising the molten alloy temperature has problems in oxidation of the molten alloy and in shortening durable lifetime of machines used in producing parts made of the alloy. Therefore, it is necessary to improve fluidity by other methods. See the last full paragraph on page 2 of Applicants' specification.

According to the present invention, as detailed in the specification, specifically adding Sn into a conventional Mg-based alloy of AZ91D group in an amount of 0.5% or more lowers the melting point of the alloy about 16°C down to about 850°Cm as shown in Fig. 3 of the present application. As shown in Fig. 4, this lowered melting point improves the molten-flow of the alloy for eased application of a Mg alloy to die-casting and injection molding for various metal products. Further, according to the present invention, adding Sn in an amount of 0.5% or more into alloy No. 11 (which corresponds to a conventional Mg-based alloy of AZ91DC group) notably increases the hardness and tensile strength of the alloy. This feature is shown in Figs. 5 and 6. As shown in Fig. 7, however, the addition is limited to 10% or less because excessive addition of Sn in an amount of more than 10% largely lowers the elongation rate thereof down to 2% or less. Thus, addition of at least 0.5% and up to about 10% still give a notable effect of a large improvement in the strength and elongation performance.

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A conventional alloy No. 11 and AZ91D, each of which contains 9% or less of Al, provide tensile strengths of 245 MPa and 248 MPa, respectively. Contrary to this, the present invention, which features an increased Al content of at least than 12%, definitely attains a higher tensile strength more than about 280 MPa with improved elongation rate due to the Sn addition. This means that the present invention offers an enhanced elongation rate of about 2% or more by addition of Sn, even through the addition of Al is at least 12%.

The attached figure shows the relationship between elongation rates and tensile strengths of Mg alloys of the present invention and conventional alloy No. 11 and AZ91D. As shown in the figure, the alloys of the present invention in the figure attain a higher tensile strength of about 280 MPa or more due to the Al content of 12% or more. See, also, Figure 8 of the subject application. Further, the Sn content in the present invention is 0.5% or more; this content, as mentioned above, provides the Mg alloy with a high elongation rate and acceptable molten-flow, which is advantageous in a Mg alloy used for injection molding in die-casting or thixotropic casting. Although this high Al content of 12% or more lowers the elongation a little bit, increased Al content on the other hand gives more enhanced tensile strength. Moreover, addition of Sn in an amount of 0.5% or more provides the alloy with a higher elongation rate of about 2% or more, enabling the Mg alloy to be applicable to a wide range of practical uses.

The prior art applied by the Examiner does not disclose and would not have suggested the Mg based casting alloy of the present invention which contains, by weight, 12 to 20% of Al and 0.5 to 10% of Sn.

Wood discloses magnesium-base alloys having increased tensile strength and

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high yield point as well as a greatly increased elongation, the alloys containing from 0.1-12.0% tin, from 0.5-10% of aluminum and from 0.1-1.0% of manganese. See page 1, left-hand column, lines 32-35. This patent discloses that the alloys may also include at least one of the class of metals composed of zinc and cadmium, amounts of zinc or cadmium being between 0.1% and 5.0% materially improving the corrosion resistance of the alloy without any undesirable effect on the physical properties. See page 1, right-hand column, lines 3-13. Note also page 1, left-hand column, lines 39-51.

Thus, the patent to Wood does not disclose a Mg based casting alloy having at least 12% Al. Applicants have found that increasing the Al content to 12 % or more increases the tensile strength of the alloy to about 280 MPa or more. While this somewhat lowers the elongation, applicants have found that the addition of Sn in an amount of 0.5% or more up to 10% provides the alloy with a higher elongation rate. Such is neither disclosed nor suggested by Wood. Nothing in the prior art described in applicants' specification would have suggested modifying Wood to arrive at the present invention. Therefore, the presently claimed invention is patentable over Wood.

The DE 1301914 abstract discloses magnesium alloys of high mechanical strength at high temperatures, made by incorporating rare metals, such as Ce, in the Mg matrix in the form of silicides. This document discloses that additional elements, such as Al, Zn, Mn, Ca, Ag, Cd, Sn and Be can be incorporated to further improve mechanical properties. This document further discloses that the alloys are suitable for casting particularly when the following elements are included (max.) Zn 7, Al 10, Mn 2, Ca 1, Ag 5, Cd 5, Sn 5, and Be 0.01 wt.%.

Thus, DE 1,301,914 also does not disclose a Mg based casting alloy having at

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least 12% Al or the advantages attendant thereto. Nothing in the prior art described in applicants' specification would have suggested modifying the teachings of DE 1301914 to increase the Al content. Accordingly, DE 1301914 does not suggest the presently claimed invention.

NO 20675 discloses a Mg-base alloy containing Al .1 to req. 10, Zn .1 to req. 7, .1 to req. Mn .1 to req. 2, Ca .1 to req. 1, Ag .1 to req. 5, Cd .1 to req. 5, Sn .1 to req. 5, Be .1 to req. 0.01 wt.% and 0.5-5% rare earth metals, e.g., Ce and 0.2-3% Si. Like Wood and DE 1301914, NO 20675 also does not disclose a Mg based casting alloy having at least 12% Al or the advantages attendant thereto. Nothing in the prior art described in applicants' specification would have suggested modifying the teachings of NO 20675 to arrive at the presently claimed invention.

King discloses magnesium alloys and their use in electric cells, the magnesium alloy containing 1-9% Al, 0-4% Zn, 0.1-5% Sn, and 0-1% Mn. See column 2, lines 11-19. This patent discloses that sludge formation in the cells may be reduced considerably by the use of magnesium alloys which contain minor amounts of tin. See column 1, lines 66-68. Thus, the King patent also does not disclose a Mg based casting alloy having at least 12% Al or the advantages attendant thereto. Nothing in the prior art described in applicants' specification would have suggested modifying the teachings of King. Accordingly, the presently claimed invention is patentable over Wood, DE 1301914 and NO 20675 or King in view of the prior art described in applicants' specification.

Claims 1, 2, 4 - 11, 22 - 24, 26, 27 and 31 stand rejected under 35 USC 103 as being unpatentable over DE 1259578 (abstract) "in view of acknowledged prior art

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admission from page 1, line 11 to page 3, line 15 of the instant specification." Applicants traverse this rejection and request reconsideration thereof.

The DE 1259578 abstract discloses Mg alloys containing metal additions, e.g., Mg_9Ba, Mg_2Co, Mg_2Ge, Mg_3Sb_2, Mg_2Si or Mg_9Sr, which are soluble in a melt but soluble only up to 0.1% below the solidus temperature. The Abstract indicates that mechanical strength of the Mg alloys may be further improved by additions of Mn .1 to req. 2.5, Al .1 to req. 13, Zn .1 to req. 9, Ag .1 to req. 16, Bi .1 to req. 11, Ca .1 to req. 1, Li .1 to req. 15, Sn .1 to req. 16, Zr .1 to req. 1, Th .1 to req. 8, rare earth metals .1 to req. 2%.

While DE 1259578 discloses a broad range for the Al content of 1 to 13% and for the Sn content of 0.1 to 16%, there is no suggestion that the Al content should be at least 12% in combination with the Sn content being 0.5 to 10%. In fact, most of the described range of Al content in DE 1259578 is outside the presently claimed range. There is no suggestion in the DE 1259578 abstract that using a Al content of at least 12% increases the tensile strength to about 280 MPa or more and that the high Al content should be done in combination with the Sn content of 0.5 to 10% to improve the elongation. See Figures 7 and 8 of applicants' specification. Nothing in the prior art described in applicants' specification would have suggesting modifying DE 1259578 to arrive at the presently claimed invention. Therefore, the presently claimed invention is patentable over DE 1259578 and the prior art described in applicants' specification.

Claims 1, 3 - 11, 22 - 24, 26, 27, 31 and 32 stand rejected under 35 USC 103 as being unpatentable over United States Patent No. 5,964,965 to Schulz et al "in view of acknowledged prior art admission from page 1 line 11 to page 3, line 15 of the instant specification." Applicants traverse this rejection and request reconsideration thereof.

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The Schulz, et al patent discloses a lightweight Mg based material or Be based material having the ability to reversibly store hydrogen with very good kinetics. The material is of the formula $(M_{1-x}A_x)D_y$, as defined in column 4, lines 20-36 of this patent. This patent further discloses that the material is in the form of a powder of particles. See column 4, line 37.

Clearly, this reference neither discloses nor would have suggested, and in fact would have taught away from, the alloy which is injection molded in a metal mold, as in the present claims, or amounts of the various components as in the present claims which provide the accomplishment that the alloy can be injection molded in a metal mold. It is emphasized that Schulz discloses material in the form of a powder of particles, which would have taught away from the alloy as presently claimed. Nothing in the prior art described in applicants' specification would have suggested modifying the Schulz et al patent to arrive at the presently claimed invention.

Claims 6, 7, 10, 23, 27 and 31 stand rejected under 35 USC 103 as being unpatentable over United States Patent No. 4,675,157 to Das et al "in view of acknowledged prior art admission from page 1, line 11 to page 3, line 15 of the instant specification."

The patent to Das et al discloses rapidly solidified magnesium based alloys containing finely dispersed magnesium intermetallic phases. This patent discloses that the alloy, generally stated, has a composition consisting essentially of about 0 to 11 atom percent aluminum, about 0 to 4 atom percent zinc, about 0.5 to 4 atom percent of at least one element selected from the group consisting of silicon, germanium, cobalt, tin and antimony, the balance being magnesium and incidental impurities. Thus, this

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patent does not disclose a Mg based casting alloy having at least 12% Al, much less a Mg based casting alloy having 12 to 20% Al in combination with 0.5 to 10% Sn. Nothing in the prior art described in applicants' specification would have suggested modifying the teachings of Das et al to arrive at the presently claimed invention.

Comments by the Examiner in Item 11 of the Office Action mailed October 23, 2002, are noted. For the reasons noted above, the prior art does not establish a prima facie case of obviousness. It is respectfully submitted that even assuming, arguendo, the applied references would have established a prima facie case of obviousness, the evidence of record in Applicants' specification, with respect to advantages achieved due to the various properties and amounts of the components of the alloy, overcome any such prima facie case, and further establish unobviousness of the presently claimed subject matter.

For the foregoing reasons, the presently claimed invention is patentable over the prior art applied by the Examiner.

Applicants note with appreciation the indication that claims 28 - 30 would be allowable if rewritten in independent form. In view of the foregoing amendments, clearly claims 28 - 30, as well as newly added claims 34 - 39 are in conditions for allowance.

In view of the foregoing amendments and remarks, favorable reconsideration and allowance of all of the claims now in the application are requested.

To the extent necessary, applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry,

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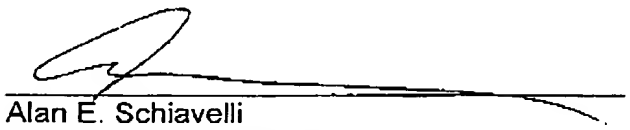
Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 503.39364X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP



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VERSION WITH MARKINGS TO SHOW CHANGES

IN THE CLAIMS:

1. (Three Times Amended)A high strength Mg based casting alloy, which is injection molded using a metal mold, and which contains, by weight, more than ~~10~~12%, and up to 17%, of Al; 0.1 to 10% of Zn; 1 to 10%, of Sn; and 0.05 to 1.5% of Mn.

2. (Three Times Amended)A high strength Mg based casting alloy, which is injection molded using a metal mold, and which contains, by weight, more than ~~10~~12%, and up to 20%, of Al; 0.1 to 10% of Zn; 1 to 10%, of Sn; and 0.05 to 1.5% of Mn, and has crystal size of 10 to 300μm.

5. (Three Times Amended)A high strength Mg based casting alloy, which is injection molded using a metal mold, and which contains, by weight, 12 to 15% of Al, 0.1 to 5% of Zn; 1 to 10% of Sn; 0.1 to 0.5% of Mn; at least one ~~kind or more than two kinds of elements~~ element selected from the group consisting of Ca, Si and rare-earth elements of which the total content is less than 5%; at least one kind of element selected from the group consisting of Sr and Sb of which the total content is less than 1%; and the remainder which is consisting essentially of Mg.

7. (Three Times Amended)A Mg based casting alloy, which is injection molded using a metal mold, and which contains, by weight, ~~2~~ 12 to 20% of Al; 1 to 10%, of Sn; and less than 1.5% of Mn.

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8. (Three Times Amended)A high strength Mg based casting alloy, which is injection molded using a metal mold, and which contains, by weight, ~~10~~ 12 to 15% of Al; 1 to 3% of Zn; 1.5 to 4.5% of Sn; 0.05 to 0.5% of Mn; and the remainder which is consisting essentially of Mg.

28. (Amended) A high strength Mg based casting alloy ~~according to any one of claims 1 to 8~~, which is injection molded using a metal mold, and which contains, by weight, more than 10%, and up to 17%, of Al; 0.1 to 10% of Zn; 1 to 10%, of Sn; and 0.05 to 1.5% of Mn, whose surface is covered with an oxide film which contains Mg of 15 to 35% by atoms.

29. (Amended) A high strength Mg based casting alloy according to claim 28, wherein said oxide film further includes an oxide of Al of less than 15% by atoms.

30. (Amended) A high strength Mg based casting alloy ~~according to any one of claims 1 to 8~~, which is injection molded using a metal mold, and which contains, by weight, more than 10%, and up to 17%, of Al; 0.1 to 10% of Zn; 1 to 10%, of Sn; and 0.05 to 1.5% of Mn, whose surface is covered with an inert oxide film having a natural immersion electric potential, 30 minutes after immersing into an aqueous solution of 0.01 mol $Na_2B_4O_7$, pH of 9.2 and a temperature of 25°C, which is greater than -1500mV.

31. (Amended) A high strength Mg based casting alloy according to any one of claims 1 to 4, consisting essentially of the Al, the Zn, the Sn, the Mn and Mg.

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32. (Amended) A high strength Mg based casting alloy according to claim 5, consisting essentially of the Al, the Zn, the Sn, the Mn, the at least one ~~kind of more than two kinds of elements~~ element selected from the group consisting of Ca, Si and rare-earth elements, and the at least one kind of element selected from the group consisting of Sr and Sb, and the Mg.

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